Integral Consulting Inc.
115 Sansome Street
Suite 200
San Francisco, CA 94104

telephone: 415.393.4750
www.integral-corp.com

MEMORANDUM

To:	Dennis Poma, ACSI
From:	Mala Pattanayek and Bridgette DeShields
Date:	August 24 2015
Subject:	Risk-Based Assessment Kapalama Military Reservation, Honolulu, HI
Project No.:	C493

The purpose of this memorandum is to evaluate whether acceptable risk levels have been achieved for the cleanup of a polychlorinated biphenyl (PCB) transformer spill at the Kapalama Military Reservation, Building 905, located in Honolulu, Hawaii (the site).

Following guidance from the U.S. Environmental Protection Agency (EPA) and the Hawaii State Department of Health (DOH), potential risk to future commercial/industrial workers from exposure to residual PCBs in soils was evaluated by estimating exposure point concentrations (EPCs) and comparing those EPCs with appropriate risk-based concentrations (RBCs) based on relevant exposure pathways and assumptions. The site soil data and results of comparisons with RBCs are discussed below. Conclusions based on the risk results are also presented.

Details of the site, including background, history, and details of the cleanup effort are presented in the work plan and sampling and analysis plan prepared by ACSI for the State of Hawaii Department of Transportation (ACSI 2015) and are not discussed in this memorandum.

SOIL DATA

Soil from the impacted area was removed and confirmation samples were collected and analyzed in April 2015. Samples were collected from the floor of the excavation (at 7 ft below ground surface [bgs]), the ledge, excavation sidewalls (up to 2 ft bgs), asphalt pavement, and the concrete wall. Subsequently, additional soil was removed from the floor (up to 9 ft bgs) and sidewalls, and limited concrete material was also removed.

Confirmation samples following this additional excavation effort were collected and analyzed in July 2015.

Analytical data from both sampling events are presented in Table 1. Aroclor 1260 was detected; no other Aroclors were detected at the laboratory reporting or detection limits. The residual soil data (i.e., the soil currently present onsite) are provided in Table 1 and were used in the risk evaluation. Aroclor 1260 was detected in 8 out of 12 samples, with detected concentrations at or less than 0.23 mg/kg in all of the samples, with the exception of the floor sample (at 9 ft bgs), which had an Aroclor 1260 concentrations of 3.4 mg/kg.

Exposure Point Concentrations

For this evaluation, two EPCs were calculated for PCBs:

- Deep Soil EPC—assumes exposure to soil down to 9 ft bgs; therefore, all residual soil PCB data were included in the EPC calculation.

- Shallow Soil EPC—assumes potential exposure to only shallow soils; therefore, the floor sample at 9 ft bgs was excluded from the EPC calculation.

The EPCs for Aroclor 1260 were calculated following EPA guidance (USEPA 2002). The upper confidence limits (UCLs) on the mean were calculated using ProUCL Software 5.0 (USEPA 2013). For the Deep Soil EPC, the UCL recommended by the program is 3.2 mg/kg and is based on the 99% Kaplan Meier (KM) Chebyshev UCL (see ProUCL Output in Attachment 1). However, based on a review of data, this recommended UCL appears to be skewed high and almost equal to the maximum detected concentration (i.e., the floor sample at 3.4 mg/kg) and, therefore, likely to bias the EPC high. Of the eight samples with detected concentrations of PCBs, seven of the samples have detected concentrations ranging from 0.045 to 0.23 mg/kg, resulting in an arithmetic mean detected concentration of 0.53 mg/kg.

EPA's human health risk assessment guidance considers the 95% UCL on the mean as an appropriate "arithmetic average of the concentration that is contacted over the exposure period" (USEPA 1989). Therefore, for this evaluation, based on the range of detected concentrations, the 95% KM Chebyshev UCL of 1.6 mg/kg was considered appropriate and was selected as the Deep Soil EPC; this EPC is based on the same distribution and statistical method as the program-recommended UCL, but is the 95% UCL instead of the 99% UCL (Attachment 1). This value is likely still biased high (almost an order of magnitude higher than the arithmetic mean).

For a commercial/industrial scenario, the exposure depth evaluated is generally shallow (up to 2 ft bgs). Therefore, exposure to soils deeper than 2 ft bgs is considered unlikely for these receptors. Using only the shallow soil data, the UCL recommended by the program is 0.13 mg/kg based on the 95% KM percentile bootstrap method (Attachment 1). This UCL was selected as the Shallow Soil EPC.

RISK-BASED CONCENTRATIONS

The RBCs for PCBs used to evaluate potential risk to commercial/industrial workers at this site included the following:

- The EPA regional screening level (RSL) of 0.99 mg/kg for Aroclor 1260; this value is based on a target cancer risk of 1×10^{-6} (USEPA 2015, updated in June).

- The DOH environmental action level (EAL) of 7.4 mg/kg for total PCBs; this value is based on a target cancer risk of 1×10^{-5} (DOH 2011, revised July 2012).

The main difference in the RBCs from the two sources is the target risk; other minor differences include body weight, dermal adherence factor, and skin surface area (this is due to the use of updated exposure parameters by EPA for the June 2015 RSLs).

ESTIMATED RISK

The Shallow Soil and Deep Soil EPCs for PCBs from the site were compared to the RBCs for the commercial/industrial worker scenario. The results are presented in Table 2 and summarized below:

- Shallow Soil—The 95% UCL of 0.13 mg/kg is less than the commercial/industrial EPA RSL of 0.99 mg/kg and the DOH EAL of 7.4 mg/kg. Also, note that this EPC is less than the residential/unrestricted EPA RSL of 0.24 mg/kg and DOH EAL of 1.1 mg/kg. Therefore, risks from exposure to shallow soils are considered acceptable.

- Deep Soil—The 95% UCL of 1.6 mg/kg exceeds the commercial/industrial EPA RSL of 0.99 mg/kg but is less than the DOH EAL of 7.4 mg/kg. A forward risk calculation using this EPC would result in estimated cancer risks of 1.6×10^{-6} and 2.2×10^{-6}, respectively, based on EPA and DOH exposure assumptions. These risks are well within and on the low end of the risk management range of 10^{-4} to 10^{-6} (USEPA 1991).

Integral Consulting Inc.

CONCLUSIONS

Based on the residual concentrations of PCBs in the shallow soils, no unacceptable risks are predicted for the commercial/industrial scenario (as well as the residential/unrestricted scenario).

Although there is an exceedance of the EPA RSL when deeper soils were evaluated, it is unlikely that commercial/industrial workers will be exposed to deep soils for a significant portion of their overall exposure duration. Furthermore, risks estimated inclusive of these deeper soils are likely biased high and on the low end of the risk management range.

Following DOH guidance, a target risk of 1×10^{-5} for PCBs is considered appropriate for this scenario; because residual concentrations of PCBs in soil are within this risk range, potential risk to commercial/industrial workers at this site is considered acceptable under DOH guidance.

Based on the statements above, no further evaluation or risk management is recommended for soils with residual PCBs at the site.

REFERENCES

ACSI. 2015. Work Plan and Sampling and Analysis Plan. Kapalama Military Reservation, Building 905. NRC Incident Report # 1110148. Prepared for the State of Hawaii Department of Transportation. ACSI. March 30.

DOH. 2011. Screening for environmental hazards at sites with contaminated soil and groundwater. Hawai'i Department of Health, Environmental Management Division, Honolulu, HI. December.

USEPA. 1989. Risk assessment guidance for Superfund, Volume I, human health evaluation manual (Part A). EPA/540/1-89-002. U.S. Environmental Protection Agency, Washington, DC.

USEPA. 1991. Role of baseline risk assessment in Superfund remedy selection Decisions. Office of Solid Waste and Emergency Response. PB91-921359. Washington, DC.

USEPA. 2002. Calculating upper confidence limits for exposure point concentrations at hazardous waste sites. OSWER 9285.6-10. U.S. Environmental Protection Agency. December.

USEPA. 2013. ProUCL Version 5.0.00 technical guide. Statistical software for environmental applications for data sets with and without nondetect observations. U.S. Environmental Protection Agency. September.

USEPA. 2015. Regional screening levels for chemical contaminants at Superfund sites. U.S. Environmental Protection Agency. June.

TABLES

Table 1. Analytical Results Summary for Polychlorinated Biphenyls

Sample ID	Sample Description	Result (4/16/15) (mg/kg)		Result (7/24/15) (mg/kg)		Representative Current Soil Data (mg/kg)	Depth (ft bgs)
TSF	Floor of Excavation	1.08 ± 0.37		3.4		3.4	9
LS-1	Ledge Sidewall	0.045	J	-		0.045	2
LF-1	Ledge Floor	0.23		-		0.23	2
SSW-1	Excavation Sidewall, Side 1	<0.21	U	-		<0.21	2
SSW-2	Excavation Sidewall, Side 2	0.01	J	-		0.01	2
SSW-3	Excavation Sidewall, Side 3	1.1		<0.07	U	<0.07	2
PA-1	Asphalt Pavement, Side 1	0.076	J	-		0.076	2
PA-2	Asphalt Pavement, Side 2	0.23		-		0.23	2
PA-3	Asphalt Pavement, Side 3	0.1	J	-		0.1	2
CW-1	Discrete, Concrete Wall	2.1		<0.2	U	<0.2	2
CW-2	Discrete, Concrete Wall	1		0.11	J	0.11	2
CW-3	Discrete, Concrete Wall	0.4		<0.2	U	<0.2	2

Summary Statistics

Minimum Detected Concentration						0.045	--
Maximum Detected Concentration						3.4	--
Arithmetic Mean of Detected Results						0.53	--
Standard Deviation of Detected Results						1.2	--

Notes:

 ft bgs = feet below ground surface

 < = not detected at the method reporting limit reported

 -- = not applicable

Qualified Data:

 J = This result is an estimated value

 U = The analyte was analyzed for, but was not detected at method reporting limit or method detection limit

Only Aroclor 1260 was detected; no other Aroclors were detected.

Table 2. PCB Risk Screening for Commercial/Industrial Worker

Exposure Point Concentrations		
Depth	*Result (mg/kg)*	*Based on*
Shallow Soil	0.13	95% KM Chebyshev UCL
Deep Soil	1.6	95% KM (Percentile Bootstrap) UCL
Risk-Based Concentrations		
Source	*Value*	*Target Cancer Risk*
EPA RSL	0.99	1.00E-06
DOH EAL	7.4	1.00E-05
Residual Risk		
Source	*Result (mg/kg)*	*Estimated Cancer Risk*
EPA RSL		
Shallow Soil	0.13	1.3E-07
Deep Soil	1.6	1.6E-06
DOH EAL		
Shallow Soil	0.13	1.8E-07
Deep Soil	1.6	2.2E-06

Notes:

exceeds the EPA RSL (but below the DOH EAL)

DOH = Hawaii State Department of Health

EAL = environmental action level

EPA = U.S. Environmental Protection Agency

KM = Kaplan Meier

mg/kg = milligrams per kilogram

PCB = polychlorinated biphenyl

RSL = regional screening level

UCL = upper confidence limit

ATTACHMENT 1
PROUCL OUTPUT

ProUCL Output for Deep Soil (down to 9 ft bgs)

User Selected Options

Date/Time of Computation	8/20/2015 10:49:27 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Conc (pcbs)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	10
Number of Detects	8	Number of Non-Detects	4
Number of Distinct Detects	7	Number of Distinct Non-Detects	3
Minimum Detect	0.01	Minimum Non-Detect	0.07
Maximum Detect	3.4	Maximum Non-Detect	0.21
Variance Detects	1.356	Percent Non-Detects	33.33%
Mean Detects	0.525	SD Detects	1.164
Median Detects	0.105	CV Detects	2.217
Skewness Detects	2.802	Kurtosis Detects	7.888
Mean of Logged Detects	-2.064	SD of Logged Detects	1.664

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.481	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.475	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

ProUCL Output for Deep Soil (down to 9 ft bgs)

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.368		Standard Error of Mean	0.283
SD	0.917		95% KM (BCA) UCL	0.925
95% KM (t) UCL	0.876		95% KM (Percentile Bootstrap) UCL	0.908
95% KM (z) UCL	0.833		95% KM Bootstrap t UCL	5.003
90% KM Chebyshev UCL	1.217		95% KM Chebyshev UCL	1.602
97.5% KM Chebyshev UCL	2.136		99% KM Chebyshev UCL	3.184

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.955	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.77	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.365	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.311	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.454		k star (bias corrected MLE)	0.367
Theta hat (MLE)	1.156		Theta star (bias corrected MLE)	1.43
nu hat (MLE)	7.268		nu star (bias corrected)	5.876
MLE Mean (bias corrected)	0.525		MLE Sd (bias corrected)	0.867

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.161		nu hat (KM)	3.86
Approximate Chi Square Value (3.86, α)	0.667		Adjusted Chi Square Value (3.86, β)	0.497
95% Gamma Approximate KM-UCL (use when n>=50)	2.128		95% Gamma Adjusted KM-UCL (use when n<50)	2.859

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

ProUCL Output for Deep Soil (down to 9 ft bgs)

Minimum	0.01		Mean	0.353
Maximum	3.4		Median	0.0605
SD	0.963		CV	2.724
k hat (MLE)	0.358		k star (bias corrected MLE)	0.324
Theta hat (MLE)	0.987		Theta star (bias corrected MLE)	1.09
nu hat (MLE)	8.595		nu star (bias corrected)	7.78
MLE Mean (bias corrected)	0.353		MLE Sd (bias corrected)	0.621
			Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (7.78, α)	2.608		Adjusted Chi Square Value (7.78, β)	2.174
95% Gamma Approximate UCL (use when n>=50)	1.054		95% Gamma Adjusted UCL (use when n<50)	1.265

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.236	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.313	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.364		Mean in Log Scale	-2.485
SD in Original Scale	0.959		SD in Log Scale	1.506
95% t UCL (assumes normality of ROS data)	0.861		95% Percentile Bootstrap UCL	0.91
95% BCA Bootstrap UCL	1.194		95% Bootstrap t UCL	5.206
95% H-UCL (Log ROS)	1.53			

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.474		95% H-UCL (KM -Log)	1.506
KM SD (logged)	1.499		95% Critical H Value (KM-Log)	3.894
KM Standard Error of Mean (logged)	0.509			

ProUCL Output for Deep Soil (down to 9 ft bgs)

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.378	Mean in Log Scale	-2.227
SD in Original Scale	0.954	SD in Log Scale	1.378
95% t UCL (Assumes normality)	0.873	95% H-Stat UCL	1.267

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL   3.184

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output for Shallow Soil (excluding floor sample at 9 ft bgs)

User Selected Options	
Date/Time of Computation	8/20/2015 2:49:18 PM
From File	ProUCL Input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Conc (pcbs)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
Number of Detects	7	Number of Non-Detects	4
Number of Distinct Detects	6	Number of Distinct Non-Detects	3
Minimum Detect	0.01	Minimum Non-Detect	0.07
Maximum Detect	0.23	Maximum Non-Detect	0.21
Variance Detects	0.00736	Percent Non-Detects	36.36%
Mean Detects	0.114	SD Detects	0.0858
Median Detects	0.1	CV Detects	0.75
Skewness Detects	0.575	Kurtosis Detects	-1.079
Mean of Logged Detects	-2.533	SD of Logged Detects	1.083

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.235	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.335	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0921	Standard Error of Mean	0.0253
SD	0.0733	95% KM (BCA) UCL	0.135
95% KM (t) UCL	0.138	95% KM (Percentile Bootstrap) UCL	0.134
95% KM (z) UCL	0.134	95% KM Bootstrap t UCL	0.142
90% KM Chebyshev UCL	0.168	95% KM Chebyshev UCL	0.202
97.5% KM Chebyshev UCL	0.25	99% KM Chebyshev UCL	0.344

ProUCL Output for Shallow Soil (excluding floor sample at 9 ft bgs)

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.289	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.176	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.317	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.513	k star (bias corrected MLE)	0.96
Theta hat (MLE)	0.0756	Theta star (bias corrected MLE)	0.119
nu hat (MLE)	21.19	nu star (bias corrected)	13.44
MLE Mean (bias corrected)	0.114	MLE Sd (bias corrected)	0.117

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	1.576	nu hat (KM)	34.68
Approximate Chi Square Value (34.68, α)	22.21	Adjusted Chi Square Value (34.68, β)	20.59
95% Gamma Approximate KM-UCL (use when n>=50)	0.144	95% Gamma Adjusted KM-UCL (use when n<50)	0.155

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0917
Maximum	0.23	Median	0.076
SD	0.0748	CV	0.816
k hat (MLE)	1.658	k star (bias corrected MLE)	1.267
Theta hat (MLE)	0.0553	Theta star (bias corrected MLE)	0.0724
nu hat (MLE)	36.48	nu star (bias corrected)	27.86
MLE Mean (bias corrected)	0.0917	MLE Sd (bias corrected)	0.0814
		Adjusted Level of Significance (β)	0.0278
Approximate Chi Square Value (27.86, α)	16.82	Adjusted Chi Square Value (27.86, β)	15.44
95% Gamma Approximate UCL (use when n>=50)	0.152	95% Gamma Adjusted UCL (use when n<50)	0.165

ProUCL Output for Shallow Soil (excluding floor sample at 9 ft bgs)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.888		**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803		Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198		**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.335		Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0879	Mean in Log Scale	-2.797
SD in Original Scale	0.0766	SD in Log Scale	0.949
95% t UCL (assumes normality of ROS data)	0.13	95% Percentile Bootstrap UCL	0.127
95% BCA Bootstrap UCL	0.131	95% Bootstrap t UCL	0.164
95% H-UCL (Log ROS)	0.228		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.81	95% H-UCL (KM -Log)	0.289
KM SD (logged)	1.047	95% Critical H Value (KM-Log)	3.088
KM Standard Error of Mean (logged)	0.414		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.104	Mean in Log Scale	-2.54
SD in Original Scale	0.0705	SD in Log Scale	0.888
95% t UCL (Assumes normality)	0.142	95% H-Stat UCL	0.256

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.138	95% KM (Percentile Bootstrap) UCL	0.134

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.